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Medical Electricity and Massage,

By H. NEWMAN LAWRENCE, A.I.E.E.

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LAWRENCE, H. Newman

A HAND-BOOK FOR OPERATORS
IN
MEDICAL
ELECTRICITY AND MASSAGE,

MEDICAL SOCIETY OF LONDON
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CONTAINING

DIAGRAMS OF THE CHIEF MOTOR POINTS AND CONCISE
TABLES, SHOWING THE ACTION OF THE MUSCLES
AND NERVES INVOLVED.

BY

H. NEWMAN LAWRENCE, A.I.E.E.,

(Managing Director of the Institute of Medical Electricity Ld.)

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[1889 ?]

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PREFACE.

THIS little book has been prepared to meet a want which has been many times prominently brought before me lately, and which, to the best of my knowledge, is not met by any other work.

It is in no sense intended as a treatise on Medical-Electricity or Massage, nor does it presume to offer instruction to Medical men except in so far as it deals with details of the application of a special form of treatment which some of them may have had little opportunity of practising.

It rather aims at supplying useful data and hints for Nurses and others who in large and ever-increasing numbers are now being trained to act, under the guidance of Medical men, as operators in Medical Electricity and Massage, and who, while possessing a fair theoretical knowledge of the arts which they may be from time to time called upon to practice, cannot from the very nature of things carry all the information they require at their finger ends nor quickly obtain experience of many points with which it is desirable that they should become acquainted

Such as these will, I hope, find this little book a pocket companion, which will assist them in practical work and enable them when a hasty reference is all that circumstances permit to settle questions which might otherwise require long and troublesome investigation for their solution.

To some it may appear that the Electrical data here given are too meagre, and do not sufficiently explain themselves, but I would submit that for the purposes of this little book a treatise on electricity would be out of place, and that what is here given will probably be found sufficient and appropriate.

The tables arranged opposite the diagrams of Motor Points are constructed to show at a glance what the action of each muscle or nerve mentioned should be, and the few tables of Physiological data given are arranged with a view to conciseness and general truth rather than to detailed accuracy, which it would be quite out of place to attempt here.

The operations of Electro-Surgery are not mentioned, because (*a*) they should always be performed by, or in the immediate presence of, a Medical man; (*b*) they require a great variety of more or less complicated apparatus for their efficient performance, and (*c*) the diversity of methods adopted by electro-surgical experts is so great that it is almost impossible at present to give general instructions which would be of any use.

Knowing how extremely valuable electricity is in many cases when properly prescribed and properly administered and also how mischievous, if not absolutely dangerous, it may be when improperly prescribed and improperly administered, I desire to raise a warning voice against the practice ot unqualified persons prescribing electricity, or of untaught and unskilled persons administering it.

Much harm is sure to result from such a course. Electricity should be no more played with than powerful drugs should be played with, and no operator who is not a medical man, however skilled in administration work he may be, should attempt to prescribe electricity on his own account.

I desire to acknowledge the kindness of the Directors of the Institute of Medical Electricity, Limited, in allowing me to make extracts from the treatment book of the Institute, and also to use the apparatus of the Institute for experiments the results of some of which are embodied in this book.

H. NEWMAN LAWRENCE.

Sept. 1889.

MEDICAL ELECTRICITY AND MASSAGE.

ELECTRICAL TERMS.

In order that we may have electricity available for Medical Applications we must have some form of electric source or generator. The generators most commonly in use are :—

A.—**Batteries** (voltaic or galvanic) in which Electricity is generated by Chemical Action.

B.—**Magneto Machines** in which Electricity is generated by the rotation of conductors in the neighbourhood of the poles of a Magnet.

C.—**Induction Coils,** or Transformers, in which a comparatively large quantity of electricity at low pressure or potential is transformed into a comparatively small quantity of electricity at high pressure or potential.

D.—**Frictional** and **Influence Machines** in which Electricity of high potential is generated by Friction or Inductive Influence.

As electricity can only be generated by the expenditure of some form of energy, *i.e.*, by the transformation into electric current of some other form of energy, (usually chemical, mechanical or thermal), and as none of these generators contain in themselves an inexhaustible store of energy, it follows that something is constantly being used up—in the Battery it is the chemical energy of one of the elements and the exciting fluid; in the Magneto and the Frictional machines it is the mechanical energy required to turn the machine.

A.—BATTERIES.

These generators are of numerous types and patterns, but all are composed of one or more cells containing two strips or rods of *metal* or similar substance such as **Zinc** (Zn) and **Copper** (Cu) or **Carbon** (C), and some exciting fluid or fluids such as dilute **Sulphuric Acid** (H_2SO_4), or a solution of **Sal Ammoniac** ($2NH_4Cl$).

The most common forms of Battery in Medical practice are the **Leclanché**: *Zinc* and *Carbon*, with *Sal Ammoniac* solution—**Bichromate**: *Zinc* and *Carbon*, with *Bichromate of Potash* and *Hydrochloric* or *Sulphuric Acid*—**Silver Chloride**: *Zinc* and *Silver*, with *Chloride of Zinc* or *Chloride of Sodium*—**Sulphate of Mercury**: *Zinc* and *Carbon*, with *Sulphate of Mercury*—**Daniell**: *Zinc* and *Copper*, with *Sulphate of Copper* and dilute *Sulphuric Acid*.

The current of electricity obtained from such batteries flows always in one direction, and is for the most part steady and **continuous**. It is spoken of as "Continuous," "Constant," "Galvanic," and "Voltaic."

B.—MAGNETO MACHINES.

These generators vary but little in form, and contain one or more bobbins of conducting wire, which by the turning of a handle are made to revolve rapidly between or near the poles of a magnet, generally a permanent magnet, but sometimes an electro-magnet, and the act of cutting the lines of force in that Magnetic field generates in them currents of electricity. These currents are collected and conducted to the terminals of the machine.

The currents of Electricity obtained from such machines are **alternately** in opposite directions. They are moreover generally very jerky and unsteady, so that Magneto machines are rather to be reckoned as instruments of torture than as medical instruments.

C.—INDUCTION COILS or TRANSFORMERS.

These are not true generators, but are sometimes called secondary generators. They really act as **transformers**, for they form an arrangement by which the character of a current of electricity is entirely changed or transformed, and rendered capable of producing a new and widely different effect upon the human body. They consist in the main of two coils of wire, the primary and the secondary, and a vibrating or oscillating contact breaker. The primary coil is in direct connection with one or more cells of a battery, and the vibrating contact breaker by means of which the current may be suddenly stopped and started again, generally many times per second; while the secondary coil is not in any way connected with the cells, but has alternating currents of electricity set up in it by virtue of its proximity to the interrupted current in the primary circuit.

Two forms of current are obtained from properly constructed Induction Coils, (*a*) the **interrupted** primary of low potential and comparatively large current-strength, which, though flowing in one direction, is interrupted frequently. (*b*) The Secondary of high potential but very small current-strength and **alternating** in nature. This Secondary Current of an Induction Coil is called the "Induced," "Alternating," or "Coil Current," sometimes the "Faradic" or "Faradaic" Current.

Some few Medical Coils contain one wire only, which is, virtually, the Primary coil, with an interrupting arrangement, and a moveable iron core by which the current-strength is regulated. They are called Electro-Magnetic machines, and the current obtained from them is of the same nature as the Interrupted Primary above-mentioned.

D.—FRICTIONAL, STATIC, AND INFLUENCE MACHINES.

Frictional or static machines are of many forms but all depend for their action upon friction. They generally consist of large discs or cylinders of glass or ebonite, a pad covered with zinc amalgam, a set of small wire brushes, and one or more spherical metal attachments called prime conductors. Influence or Induction machines are somewhat similar in appearance but depend upon Electro-static induction or influence for their action rather than upon friction. These generators require to be put in action by the hand or other power. The electricity generated by them is called "Static," "Frictional," or "Franklinic" electricity. It is of very high potential but very small current-strength and flows or rather rushes in one direction.

FORMS OF CURRENT.

We have then, from the Generators enumerated above, five forms of electric current generated, each of which has its own special uses in the treatment of particular cases, viz. :—

1. The **"Continuous,"** "Voltaic," or "Galvanic" current obtained direct from a Battery having for its chief characteristic a steady continuous flow in

one direction. It is capable of strong chemical action, decomposes fluids, and produces, when applied to the human body, an unpleasant scalding sensation, especially under the negative pole, and an acid metallic taste in the mouth. Unless the current be suddenly made or broken it does not produce any muscular contraction.

2. The **alternating**, jerky current obtained from a Magneto machine, having for its chief characteristic rapid changes of direction. It is capable of very little, if any, chemical action, does not decompose fluids, but produces strong and violent muscular contraction, and a sensation at both terminals of pricking as from many rather blunt needles.

3. The "**Interrupted**" primary of an Induction Coil, having for its chief characteristic a rapidly interrupted flow in one direction. It is capable of slight decomposing action on fluids, and produces a steady but firm contraction of the muscles, and a pricking sensation as from very fine pointed needles.

4. The "**Alternating**" or "Induced" of the Secondary Coil having characteristics very similar to those of No. 2, but much more steady and less violent in its action on the body.

5. The "**Static**," "Frictional," or "Franklinic" electricity from the Frictional or Influence machine is chiefly to be noticed for its high potential and consequent power of overcoming resistance. It rushes immediately over a large surface and consequently is used in Therapeutics mainly to supply charges of electricity to the entire bodies of patients who are for the purpose placed upon stools or stands insulated, *i.e.*, electrically separated from surrounding objects. When a conductor, otherwise insulated, is

brought into contact with one of the poles of a Frictional or Influence machine in operation it becomes electrically charged, *i.e.*, covered with electricity of high potential. This charge remains so long as the insulation is good enough to prevent its escape, but if the insulation be disturbed in any way, as by the immediate proximity of another conductor connected to earth, or having upon it a charge of opposite polarity, this charge rushes away by the channel offered and produces a spark in its passage through the air. A person so charged is capable of giving out sparks from any part of his body when any conductor is brought near him, and these sparks produce an unpleasant pricking sensation and a sharp shock. A charge of Static electricity is sometimes compared to the energy possessed by a wound up or compressed spring, which energy is stored up so long as the spring is compressed, but discharges itself in one sudden effort directly the spring is released. It will be seen therefore that electricity in the form of static charges differs widely from the forms of current enumerated above.

Conductors.—A Conductor of electricity is any substance which will allow electricity to pass through or along it. Ordinary conductors are wires of some metal, such as copper, silver, or iron. The human body is also a conductor under certain conditions.

Circuit.—The system of conductors by means of which electricity flows out from and returns to the battery or other generator is called the circuit.

Current.—The quantity of electricity flowing through or past any point in a conductor during any given time is called the current, and its unit of measurement is called the "ampère," but this is far too large for medical purposes, therefore the unit of measurement in medical electricity is the "milli-ampère" or one-thousandth of an ampère.

Galvanometer.—The instrument for measuring current is called a "Galvanometer," and is of many forms. For medical purposes the galvanometer should be graduated in milli-ampères, and should have a range of from 0 to 50 for use in most cases, but in some special cases, and in electric bath work an instrument recording up to 300 milli-ampères is necessary.

Electromotive force.—Difference of potentials at the poles of the generator produces electromotive force which is analagous to the differences of pressure at the two ends of a water pipe necessary to produce a flow of water through the pipe, and is that by which the electric current flows or is driven through or along a conductor. Its unit of measurement is the Volt.

Volt-Meter.—The instrument for measuring electromotive force is called a Volt-Meter. Currents are said to be of high or low potential in accordance with the degree of electromotive force at which they are forced through the circuit by the potential differences between the poles of the generator.

Resistance.—The obstruction which any substance offers to the flow of electricity is called Resistance, and its unit of measurement is called the Ohm.

Conductivity.—The inverse of Resistance is called Conductivity.

Insulation consists in the isolation or confinement of electric currents and charges, in such a manner that they may not escape from their proper conductors, nor leak away in unexpected places in their passage along such conductors. It follows, therefore, that all substances which are bad conductors, such as dry cotton, silk, india rubber, gutta-percha, dry air, glass and wood, &c., are good insulators, but none of them are perfect insulators; the difference between the conductivity and the insulation power of substances is one of degree only. For instance, a current passing along a wire, at, say, 2 volts pressure might be perfectly insulated by a few turns of silk, but if the pressure be increased to, say, 500 volts, many turns of silk would not be enough to insulate it.

Ohm's Law.—The relation between Current, Electromotive force and Resistance is known as Ohm's Law, and is expressed by the Equation: Current in Ampères $= \dfrac{\text{Electromotive force in Volts}}{\text{Resistance in Ohm's.}}$ or shortly $C. = \dfrac{E}{R}$ where C. stands for current in Ampères, E. for electro-motive force in Volts, and R. for resistance in Ohm's.

Switch Board.—The Board usually placed at the top or front of a Medical Battery (but which may be quite separate) on which the knobs, buttons, screws, switches, etc., are placed from which the electricity may be taken to a distance from the battery, is called the switch board, or sometimes the element board, but this latter term is rather misleading.

Terminals.—The termination of the wires which conduct the electricity from the cells to the switch board are called terminals or binding screws of which one is called the positive pole and is marked +, and the other is called the negative pole and is marked —, and is *always* connected to the Zinc of a battery.

Poles.—The positive pole is that by which the electricity flows or is assumed to flow out from the Battery (when the outer circuit is completed), and the negative pole is that by which the electricity returns or is assumed to return to the Battery.

Rheophores.—The flexible conducting wires which conduct the electricity from the terminals on the switch board to a distance are called Rheophores. These rheophores should always be well insulated, *i.e.*, covered or coated with some non-conducting substance.

Electrodes.—The conducting media of many and various forms which are connected to the distant end of the Rheophores, and are used to conduct the electricity to the patient by direct contact are called Electrodes.

Anode and Kathode.—When used for a continuous current the electrode attached to the positive pole is sometimes called the Anode, and that attached to the negative pole the Kathode. Anode, way up or out for current. Kathode, way down into battery.

HINTS ABOUT APPARATUS.

Great care and cleanliness are most necessary for the proper management and preservation of electro-medical apparatus. None of the exciting fluid of a battery, should it escape through accident or leakage, must ever be allowed to remain on the switch-board or on any of the contacts. It should be wiped off immediately and thoroughly or much damage will otherwise result. All terminals, contact screws, or knobs and connecting ends of rheophores, must be kept clean and bright; no grease or dirt of any kind must be allowed to remain thereon, or inefficient action resulting from bad electrical contact will result.

The contact points of the interrupter, or vibrating hammer attached to induction coils, should be occasionally cleaned with sandpaper or a fine file.

When the moving mechanical parts of any apparatus require oiling to restore proper freedom of action, use thin oil, apply only the smallest quantity possible to bring about the desired result, and never let it run about on to other parts of the apparatus, for all oils are more or less powerful insulators, and if allowed upon conducting surfaces, will bring about electrical inefficiency while promoting mechanical efficiency.

ELECTRIC DATA CONCERNING THE HUMAN BODY.

The human body in its normal condition is a bad conductor of electricity ; that is to say, it has considerable Resistance. This Resistance lies mainly in the epidermis or outer skin, and is so great that, when the skin is unmoistened, the Resistance of the body from hand to hand or foot to foot is seldom less than 10,000 ohms, and is often very much more. Some idea of the extent of this resistance may be gathered from the fact that the Resistance of an Atlantic cable is about 13,000 ohms. When applying electricity to the body it is usual to moisten the skin of the parts to which the electrodes are applied with warm salt and water, and this, when the skin is well soaked, has the effect of reducing the Resistance to from 1,000 to 2,000 ohms.

Exhaustive experiments upon the effect of soaking the skin with salt and water were made some time ago by Mr. Wm. Lant Carpenter, and the results arrived at, published in *Health* of Oct. 5th, 1883, are given as follows :—

Into the feet of a pair of socks were fastened soles of tinfoil, connected with a constant current battery and with measuring instruments. The socks having been put on, and the experimenter standing in them, the resistance in this circuit was measured with the dry skin, and found to be 10,300 ohms. The feet were then put into two separate vessels of salt and water, and the resistance was measured at frequent intervals, with the following results :—

	Min.	Ohms.
Dry skin	—	10,300
Salt and water	1	4,300
,,	5	2,500
,,	7	2,100
,,	10	1,900
,,	15	1,720
,,	20	1,540
Salt and water	25	1,470
,,	30	1,400
,,	35	1,290
,,	40	1,250
,,	45	1,230
,,	50	1,200
,,	60	1,190 to 1,200

The Resistance of the body to alternating currents, such as the Induced of a secondary coil (Faradic or Coil current), is only about one-half what it is to Continuous (Constant, Galvanic, or Voltaic) currents. Thus, if the Resistance of a patient to continuous current be 1,200 ohms, it will only be 600 or 700 ohms to the alternating current. This curious fact is of much importance physiologically, and was first pointed out by Dr. W. H. Stone in his Lumlian lectures delivered before the Royal College of Physicians, April, 1886.

As illustration of the Resistance of the human body, I give here a few actual measurements of the resistance of patients, taken from the treatment book of the Institute of Medical Electricity :—

Table of Resistances of 10 patients (taken from the treatment book of the Institute of Medical Electricity, Ld.) :—

PATIENT.	PART TREATED.	RESISTANCE IN OHMS.
Mr. H. -	Spine (lumbar region) to ankle - - - - -	1200
,, F. -	Cervical region to sacral region - - - - -	1729
,, C. -	Through knees - - -	620
,, G. -	Knee to foot - - - -	987
,, S. -	Hand to hand - - - -	1100
,, S. -	Foot to foot - - - -	1125
,, B. -	Neck to feet - - - -	925
,, W. -	Neck to Brachial Plexus	833
Mrs. G. -	Neck to hand - - - -	2170
Mr. K. -	Through knees - - -	1225

Table of Resistances of 10 patients when undergoing an *Electric Bath* (taken from the treatment book of the Institute of Medical Electricity, Ld.) :—

PATIENT.	PART TREATED.	RESISTANCE IN OHMS.
Miss D. -	Neck to feet - - - -	490
,, H. -	Hands to feet - - - -	2427
Mr. G. -	,, ,, - - - -	1233
Mrs. B. -	Neck to feet - - - -	653
Mr. K. -	Hands to feet - - - -	730
,, G. -	Shoulder to hand - - -	890
Miss M. -	Neck to feet - - - -	490
Mrs. K. -	Shoulder to feet - - -	980
Mr. H. -	Neck to feet - - - -	986
,, R. -	Spine to feet - - - -	986

Table showing the variation of Resistance in the same 5 patients on 3 different days (taken from the treatment book of the Institute of Medical Electricity, Ld.) :—

PATIENT.	PART TREATED.	DATE.	R. IN OHMS.	DATE.	R. IN OHMS	DATE.	R. IN OHMS.
Mr. H.	(in Bath) Neck to Feet	Nov. 14	633	Nov. 15	700	Nov. 16	529
Miss H.	Lumbar region to thigh	Nov. 12	2,066	Nov. 13	1,771	Nov. 14	2,480
Mr. B.	(in Bath) Neck to Feet	Nov. 14	754	Nov. 17	1,240	Nov. 21	1,233
Mr. C.	Neck to Brachial Plexus	Jan. 16	1,240	Jan. 19	1,033	Jan. 21	987
Miss H.	(in Bath) Hands to Feet	Feb. 26	2,020	Feb. 27	1,929	Mar. 13	1,930

These resistances were all taken, as nearly as possible, under the same conditions, and with the continuous current.

DOSAGE.

The dose of electricity should be defined for the continuous current as *so many milli-ampères for so many minutes*, and is now generally prescribed in this manner by medical men.

The method, rapidly becoming a thing of the past I am glad to note, of prescribing a dose as *so many cells* is wrong, absurd, and haphazard in the extreme, for cells are of many kinds and sizes, each kind and size differing from the other in power, the cells of medical batteries are never constant so that the same battery does not possess the same power from time to time, and if it did, patient's resistance varies, therefore, the current employed would vary.

To prescribe this, as I have known it done, in some of the large hospitals even, is somewhat analogous to prescribing so many bottles of a strong medicine without any instructions as to the size of such bottles, and then putting that prescription into the hands of a totally inexperienced nurse. As an illustration take the following: A doctor orders a patient 20 cells of Constant Current 3 times a week, on Monday the Battery is in fairly good order and the E.M.F. of 20 cells is 30 Volts, the patient's resistance is 1000 Ohms, then by Ohm's law $\left(C = \frac{E}{R}\right)$ $C = \frac{30}{1000}$ $\therefore C = 0{\cdot}003$ or 3 milli-amperes; on Wednesday the battery having had much use and probably rough handling, has nearly run down so that the E.M.F. of 20 cells has fallen 10 Volts, $C = \frac{10}{1000} \therefore 0{\cdot}001$ or 1 milli-ampere; on Friday a new battery is used having an E.M.F. of 40 Volts for 20 cells, $C = \frac{40}{1000}$ $\therefore C\ 0{\cdot}004$ or 4 milli-amperes. Thus, in three days three widely different doses are administered under the same prescription, even assuming that the other conditions remain constant which is very seldom the case, especially as regards the resistance. As evidence that the resistance of the same individual varies considerably from day to day, and also from hour to hour, I give on page 24 a diagram of observations taken at the Institute of Medical Electricity. It shows the variation in the conductivity (conductivity varies inversely as the resistance) of two persons during 24 consecutive hours.

It is, therefore, necessary always to measure the dose by having a galvanometer graduated in milli-amperes, in circuit when administering the Continuous Current; only thus can it be known that the right quantity of current is passed at each application. To refer again to Ohm's law, C is given by the prescription and must remain constant, so then if R varies, E must also be varied, and this is generally done by adding to or taking from the number of cells in circuit. For instance, if a dose of 10 milli-amperes be prescribed C = 0·010, if the Resistance (R) on one day be 2,000 Ohms, the E required must be 20 Volts, (E = C R). Now, if on another day R has altered to 1,500, then E must be only 15 volts; and supposing the battery to be in good order, and that its E.M.F. per cell is 1·3 or a little over, then on the first day 16 of such cells must be used, and on the second only 12.

Unfortunately, the alternating or induced current cannot be so easily measured, as there is not yet in the market, that I am aware of, an instrument capable of measuring accurately the very small quantity of such current that can be borne by human beings under ordinary conditions.

It is a curious fact, of which I cannot here attempt an explanation, that though most persons can bear with ease several milli-ampères of continuous current, they cannot bear one, or anything like one, milli-ampère of alternating current.

An instrument for measuring the doses of current from a coil battery will, therefore, have to be graduated in micro-ampères, *i.e.*, millionths of an ampère. In the absence of any such instrument the dose of current from the coil is generally measured by (*a*) the relative positions of the primary and secondary coils, (*b*) the position of a sliding core, (*c*) the amount of resistance in the primary circuit, (*d*) the number of vibrations per second of the contact breaker in primary circuit.

The measurements obtained by any of these methods are tolerably reliable **for the particular apparatus in use,** but at best are only comparative, and, of course, are of no use whatever for general prescriptions.

Fortunately the chemical action of the alternating current on the body is infinitely smaller than that of the continuous current, so that an overdose or underdose of this form is not of such great importance; but the need for a reliable measuring instrument of the order named above is **very great,** and the inventor who can introduce such an instrument which shall be *handy* and *accurate* will confer a distinct benefit upon the science of Medical Electricity, and can be pretty sure of a ready sale for his instrument.

Care must be taken to distinguish between the **sensibility** of the patient and his **Resistance** as they are by no means the same thing. If two patients having the same resistance, have the same strength of current passed one is almost sure to feel it more than the other. Even the same patient often feels the same strength of current more one day than another. The resistance of the same patient often varies much under changes of time and circumstance, apparently apart from the action of the particular disease he or she may suffer from. Generally speaking exercise and excitement reduce the resistance while eating, or rather the earlier processes of digestion and depression increase the resistance.

GENERAL HINTS ABOUT ELECTRICAL APPLICATIONS.

1. See that your battery is in working order before you touch the patient. A convenient method of doing this is to place your electrodes in the same vessel of water, and then on completing the circuit for a second or two note the deflection of the galvanometer needle. If the needle deflects freely then proceed to the patient; if it does not, examination of the connections, and perhaps of the battery, will be necessary.

2. See that the binding screws or other connections of electrodes and rheophores are clean and screwed up tight.

3. See that the salt and water for moistening the skin and damping electrodes is neither too hot nor too cold (about 95° F. is best), and that the salt in solution is not too strong (about ½-oz. common salt to one quart of water is best).

4. See that your patient is conveniently placed and is in a comfortable position.

5. When pad electrodes are used wipe off the

superfluous water with a cloth before applying to the body, and do not let water run, drop, or splash upon the patient's clothes, especially upon underlinen.

6. Never turn on all the current dose immediately, but starting with the smallest possible current gradually increase it till the proper dose is reached.

7. When the time is up turn the current off gradually in the same way.

8. Never give the patient anything even approaching a shock, unless the doctor has specially ordered it.

9. Always, at once, clean and wipe the electrodes after use.

10. See that the switches are all turned off in the battery.

11. Put straight in the room any disorder which the operation may have occasioned.

12. Keep your battery and its connections clean and bright at all times; a few minutes given daily to this matter may easily save pounds in the cost of repairs.

It is very advisable and almost necessary that any operator in medical electricity who wishes to be really proficient in his work, should try upon his own body the effects of the different applications he may be called upon to make upon others. By so doing he knows, with a fair amount of accuracy, the particular sensations likely to be produced in his patient; and this knowledge he will often find a great assistance in dealing with sensitive and fanciful people.

In the same way, it is necessary for the operator to try on himself first any new coil or other apparatus which supplies alternating currents, or he may be quite at sea as to the strength of current he administers to his patient. With the continuous current, this is not necessary, so long as there is a milli-ampèremeter or other current measurer in circuit, for the instrument indicates the current strength far more accurately than the operator's sensations could do.

TABLE OF CHIEF BONES IN THE HUMAN BODY

HEAD.

Cranium.
Frontal.
Parietal 2.
Temporal 2.
Occipital.
Ethmoid.
Sphenoid.

Face.
Nasal 2.
Upper maxillary 2
Lower maxillary.
Malar 2.
Palate 2.
Lachrymal 2.
Vomer.
Inferior turbinated 2.

(Hyoid, or throat bone.)

BODY.

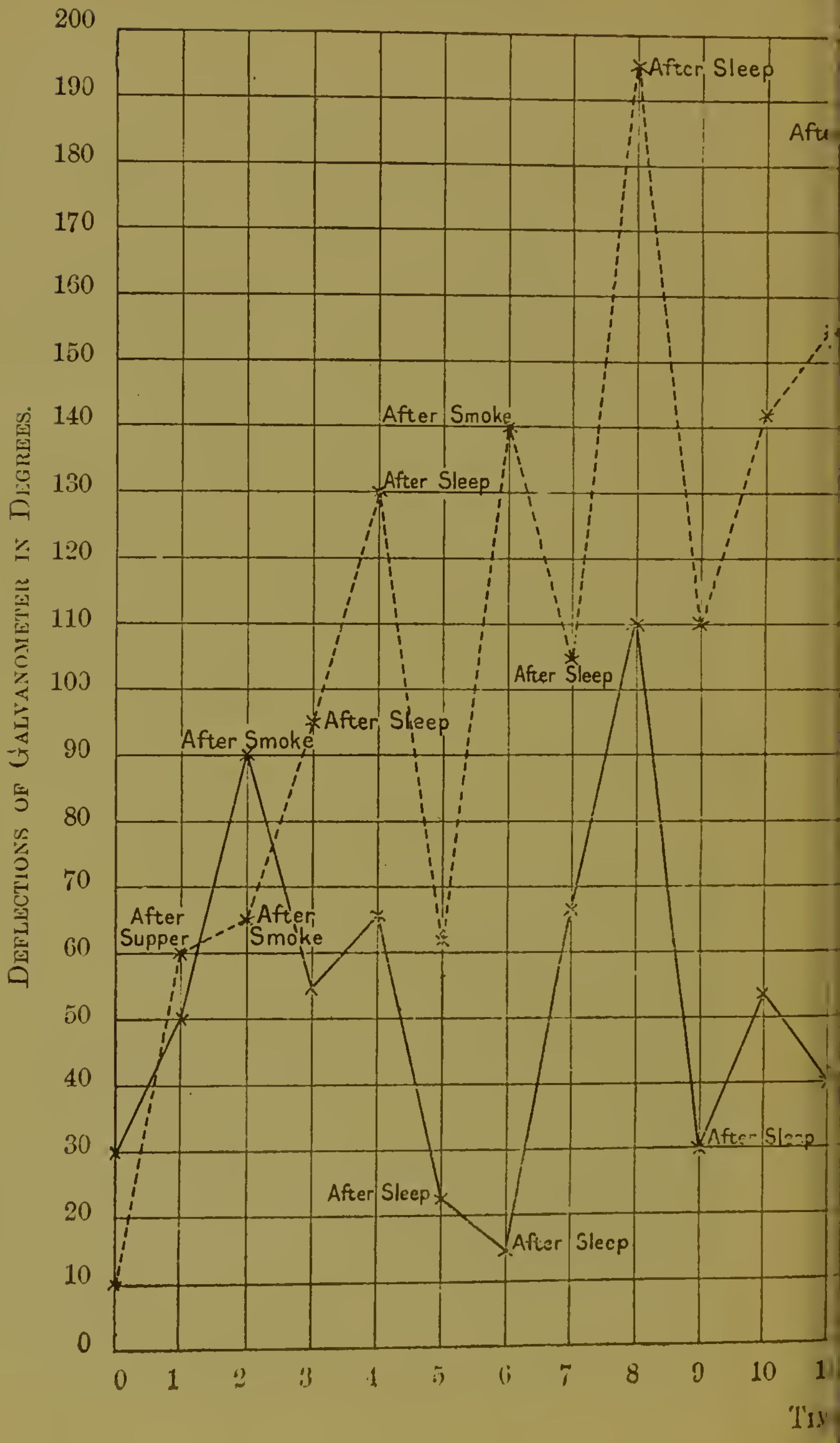
Vertebral or Spinal Column.—7 Cervical or neck vertebræ.
12 Dorsal or back do.
5 Lumbar or loin do.
Clavicle—2.
Ribs.—7 Pairs true ribs.
5 do. false do.
Sternum.—Breast bone.
Pelvis.—Ossa Innominata.
Sacrum.
Coccyx.

Arm.
Scapula or Shoulder Blade.
Humerus (upper arm).
Ulnar, **Radius** (forearm).
Carpal 8 (wrist)
Meta-carpal 5 (palm).
Phalanges 14 (fingers, 2 to thumb and 3 to each of other fingers).

Leg.
Femur or thigh bone.
Patella or knee pan.
Tibia or shin bone.
Fibula or splint bone.
Tarsal 7 (ankle).
Meta-tarsal (instep).
Phalanges 14 (toes, 2 to great toe and 3 to each of other toes.

Curve shewing the variations in Con

Observations taken at the Institute



ITY OF 2 MEN DURING 24 CONSECUTIVE HOURS.

EDICAL ELECTRICITY, JAN. 1ST AND 2ND, 1889.

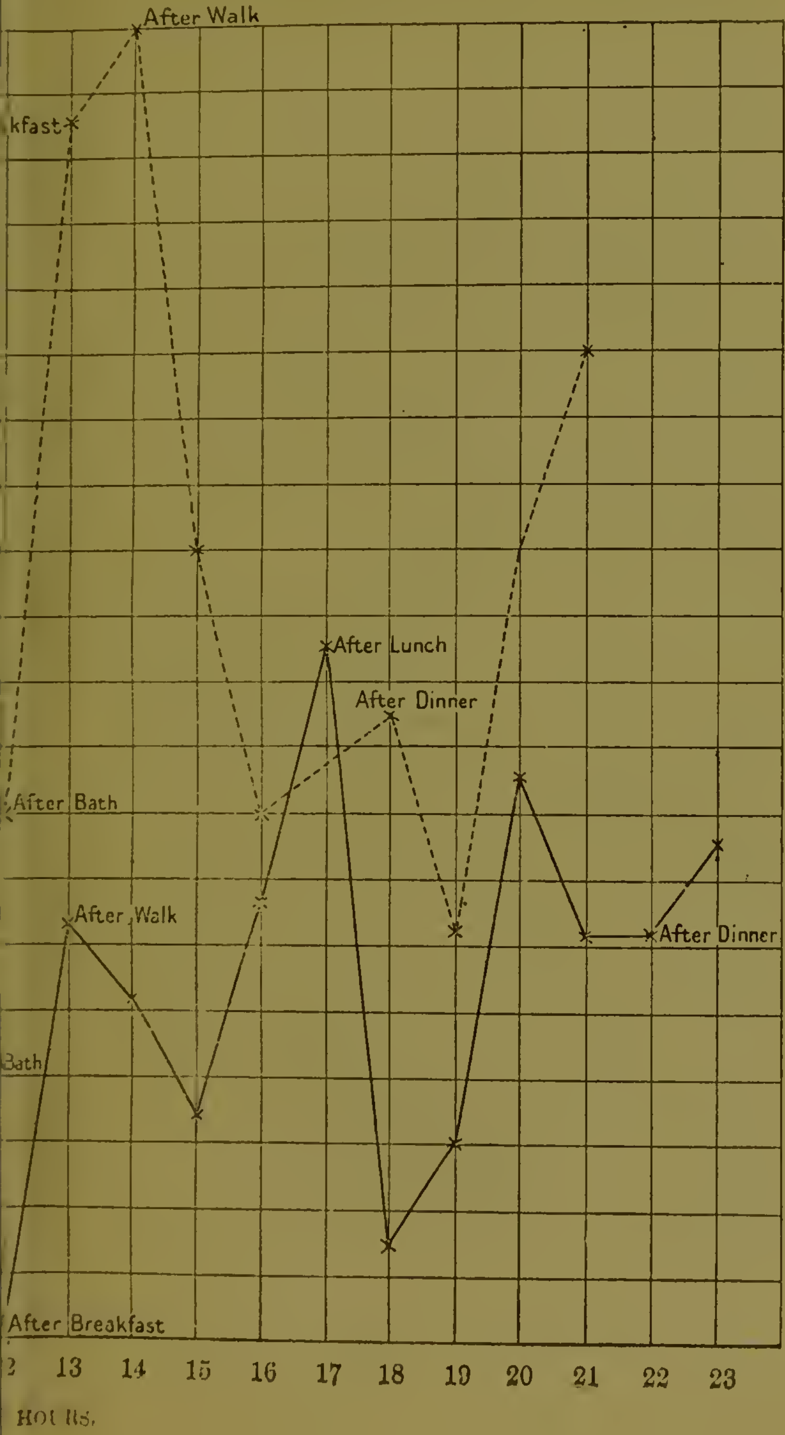


PLATE I.

MOTOR POINTS ON HEAD AND NECK.

M = Muscle. N = Nerve.

Muscle.	Action.
Frontalis	Raise skin of forehead, eyebrows, and eyelids.
Corrugator supercilii	Corrugate inside of eyebrow.
Orbicularis palpebrarum	Close eyelid.
Digastricus	Opens mouth.
Splenius	Draw head back.
Trapezius	Elevate the shoulder, depress head backwards, and fix scapula.
Hyoid	Move hyoid bone and open mouth.
Triangulus menti	Depress angle of mouth.
Quadratus menti	Depress lower lip.
Levator menti	Raise skin of chin.
Orbicularis oris	Close and corrugate the mouth.
Zygomaticus major **Zygomaticus minor**	Raise and draw back the angle of mouth.
Nasal	Dilate, elevate, and depress nostrils.

Nerves.	Muscles they Supply.
Facial	To muscles of expression.
Spinal Accessory	To trapezius and sterno mastoid.
Brachial Plexus	To muscles of upper limbs.

PLATE I.

MOTOR POINTS.—HEAD AND NECK.

M = Muscle. N = Nerve.

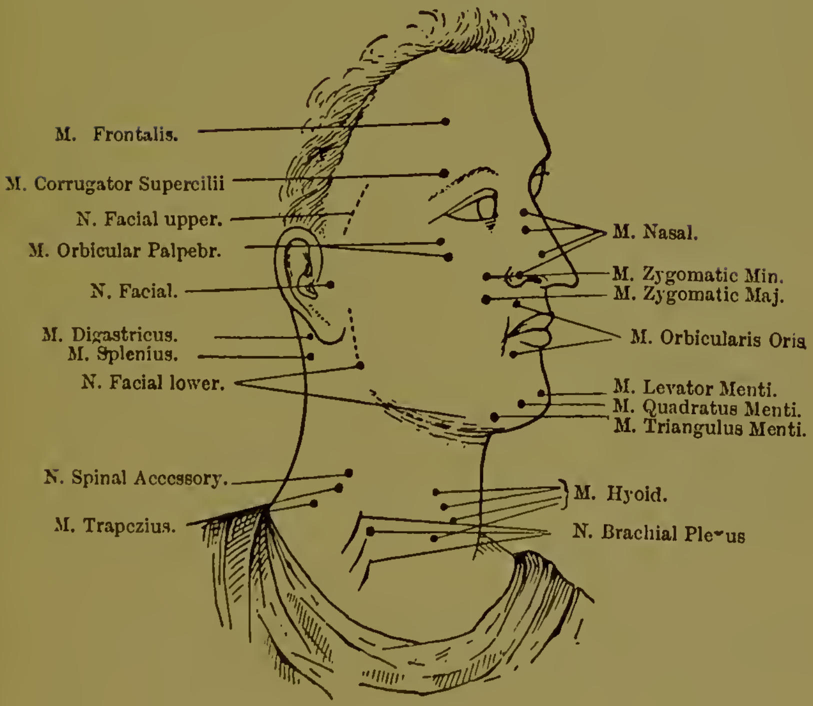


PLATE II.

MOTOR POINTS.—FRONT OF ARM.

M = Muscle. N = Nerve.

MUSCLE.	ACTION.
Deltoid	Raise the arm at right angles to side.
Biceps	Flex forearm, rotate radius outwards.
Brachialis Anticus	Flex forearm.
Supinator Longus	Supinate the forearm and hand.
Pronator Teres	Flex forearm, rotate radius inwards.
Flexor carpi radialis	Flex forearm and hand.
Flexor digit. sublimis	Flex forearm and fingers.
Flexor pollicis longus	Flex thumb and forearm.
Abductor pollicis brevis	Abduct thumb.
Opponens pollicis	Flex thumb.
Flexor pollicis brevis	Flex thumb.
Lumbricales	Partly flex and partly extend the fingers.
Opponens digit. min.	Flex little finger.
Flexor digit. min.	Flex do.
Abductor digit. min.	Abduct do.
Palmaris brevis	Corrugate skin of palm.
Flexor digit. prof.	Flex forearm and fingers.
Flexor carpi ulnaris	Flex forearm and hand.
Triceps	Extend forearm, depress neck of scapula.

NERVES.	MUSCLES THEY SUPPLY.
Musculo-cutaneous	Biceps and brachialis anticus.
Median	Pronator muscle, muscles of thumb, first and second fingers, and outer side of third finger.
Ulnar	Flexor carpi ulnaris, fourth finger and inner side of third finger.

PLATE II.

MOTOR POINTS.—FRONT OF ARM.

M = *Muscle*. *N* = *Nerve*.

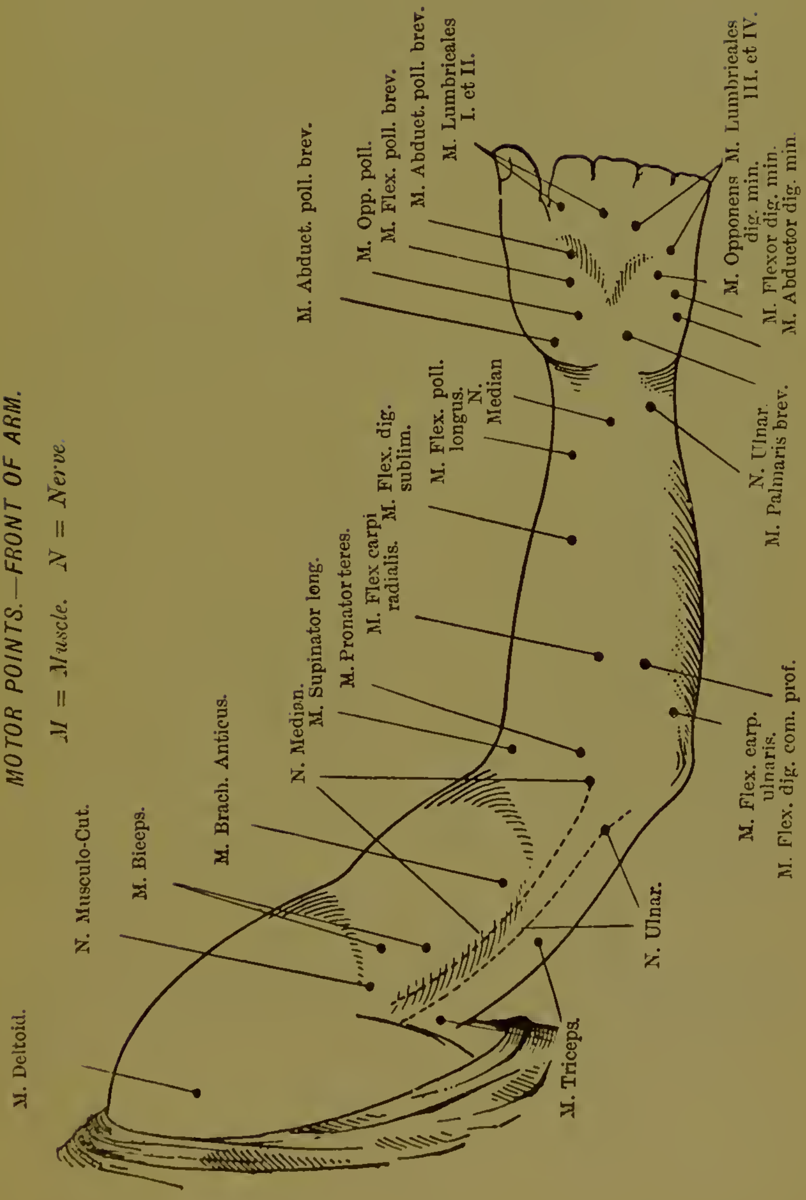


PLATE III.

MOTOR POINTS.—BACK OF ARM.

M = *Muscle.* *N* = *Nerve.*

Muscle.	Action.
Deltoid	Raise arm at right angles to side.
Brachialis Internus	Flex forearm.
Supinator longus	Supinate forearm and hand.
Radialis extensor long.	Extend do. do.
Radialis extensor brev.	Do. do. do.
Extensor digit com.	Do. fingers do.
Abduct. pollicis longus	Abduct thumb do.
Extensor pollicis brevis	Extend do. do.
Extensor pollicis longus	Do. do. do.
Inteross. dorsalis	Abduct fingers.
Abductor digit min.	Do. little finger.
Extensor Indicis	Extend first do.
Extensor digit min.	Do. little do.
Supinator brevis	Supinate the hand and forearm.
Ulnar extensor	Extend the hand.
Triceps	Do. forearm and depress neck of scapula

Nerve.	Muscles it Supplies.
Musculo spiral	Extensor muscles of forearm and all muscles of back of arm and hand.

PLATE III.

MOTOR POINTS.—BACK OF ARM.

M = Muscle. N = Nerve.

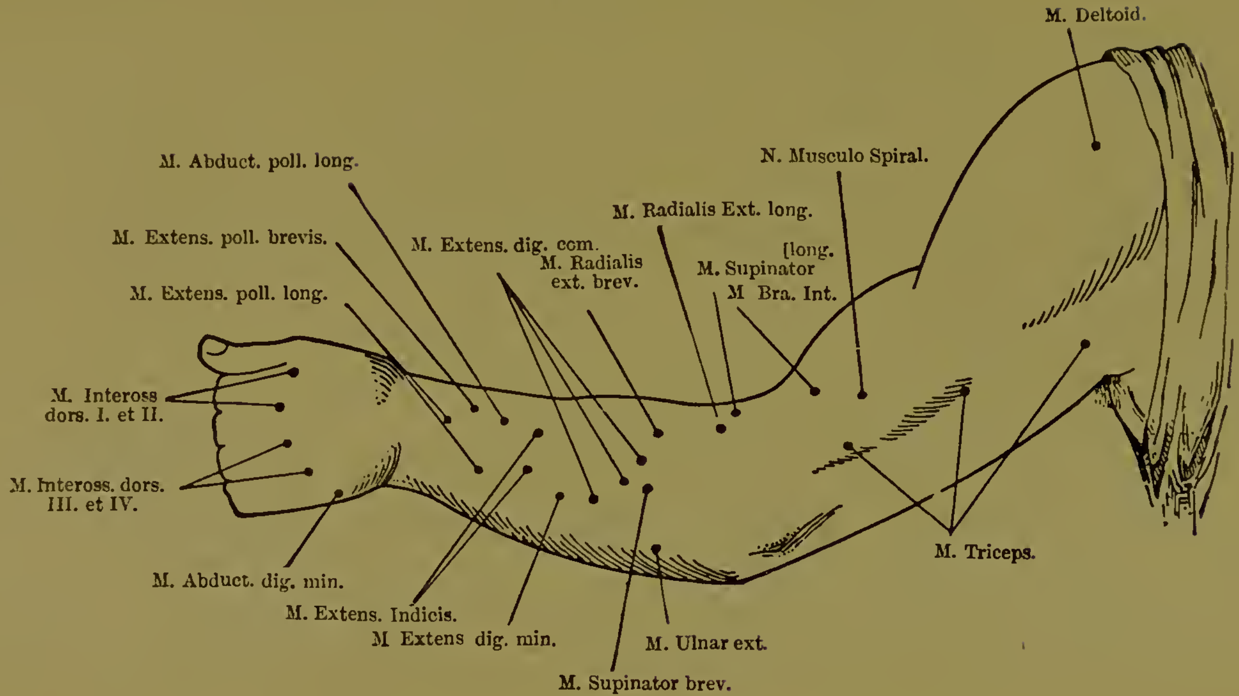


PLATE IV.

MOTOR POINTS.—FRONT OF LEG.

M = Muscle. N = Nerve.

MUSCLE.	ACTION.
Pectineus	Adduct and flex thigh.
Adductor magnus	Do. thigh.
Adductor longus	Do. do.
Crureus	Extend leg upon thigh.
Vastus internus	Do. do.
Tibialis anticus	Flex ankle, adduct foot, and raise its inner edge from ground.
Extensor digit. longus	Extend toes and flex ankle.
Peroneus brevis	Flex ankle.
Extensor hallucis longus	Extend great toe and flex ankle.
Extensor digit. brevis	Do. the toes.
Interossii dorsalis	Abduct do.
Abductor digit. min.	Do. and flex little toe.
Flexor hallucis longus	Flex great toe.
Soleus	Extend ankle and raise foot from ground.
Peroneus longus	Flex ankle, turn foot outwards, and raise outer edge.
Gastrocnemius	Extend ankle-joint and raise foot from ground.
Vastus externus	Extend leg.
Rectus femoris	Flex hip and extend leg.
Quadriceps extensor	Extend leg.
Tensor vaginæ femoris	Assist gluteus maximus.

NERVES.	MUSCLES THEY SUPPLY.
Crural	Flexors of thigh and extensors of leg.
Obturator	Adductor muscles of thigh.
Peroneal	Cutaneous, outer side of leg.

PLATE IV.

MOTOR POINTS. FRONT OF LEG.

M = Muscle. N = Nerve.

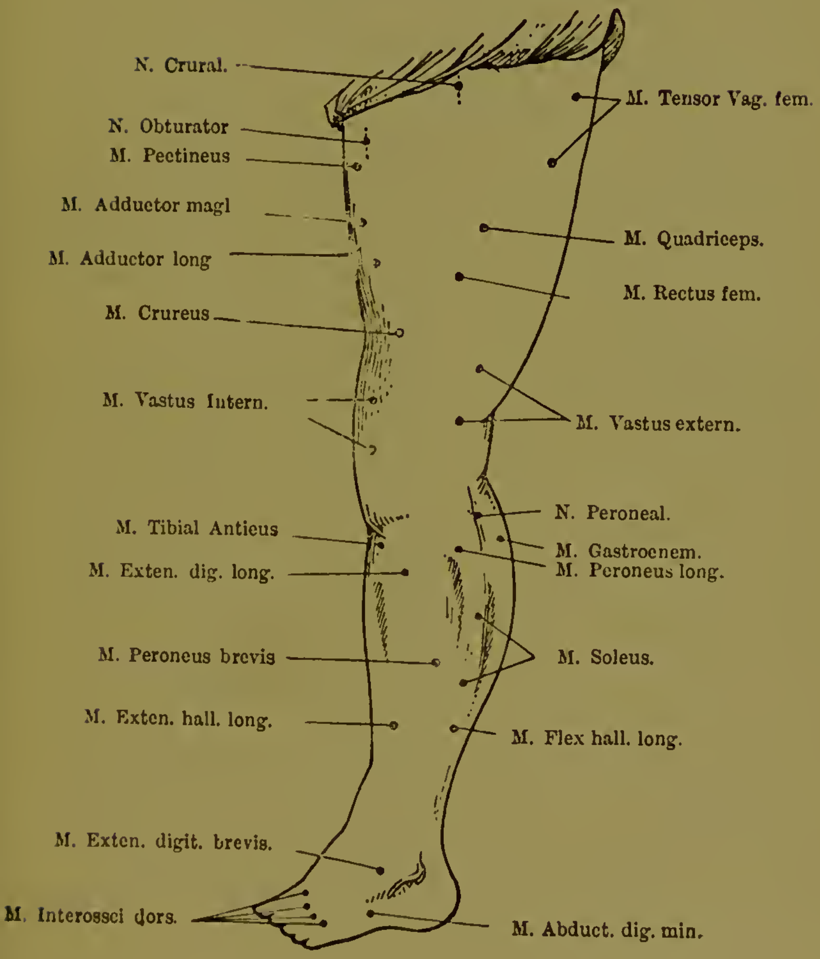


PLATE V.

MOTOR POINTS.—BACK OF LEG.

M = Muscle. N = Nerve.

MUSCLE.	ACTION.
Biceps femoris	Flex knee, extend thigh and rotate it outwards.
Gastrocnemius	Extend ankle, raise body in walking and flex knee.
Soleus	Extend ankle, and assist in raising foot from ground.
Flexor hallucis longus ...	Flex great toe.
Flexor digit. com. long ...	Flex toes, and assist in raising body.
Semimembranosus	Extend thigh, flex knee, and rotate leg inwards.
Semitendinosus	Extend thigh, flex knee, and rotate leg inwards.
Adductor magnus	Adduct, flex, and rotate thigh outwards.
Gluteus maximus	Extend hip joint, abduct thigh and rotate it outwards.

NERVE.	MUSCLES THEY SUPPLY.
Peroneal	Cutaneous and muscles on outer side of leg.
Tibial	Muscles at back of leg and sole of foot.
Sciatic	Hamstring muscles and Cutaneous.

PLATE V.

MOTOR POINTS. BACK OF LEG.

M. = Muscle. N = Nerve.

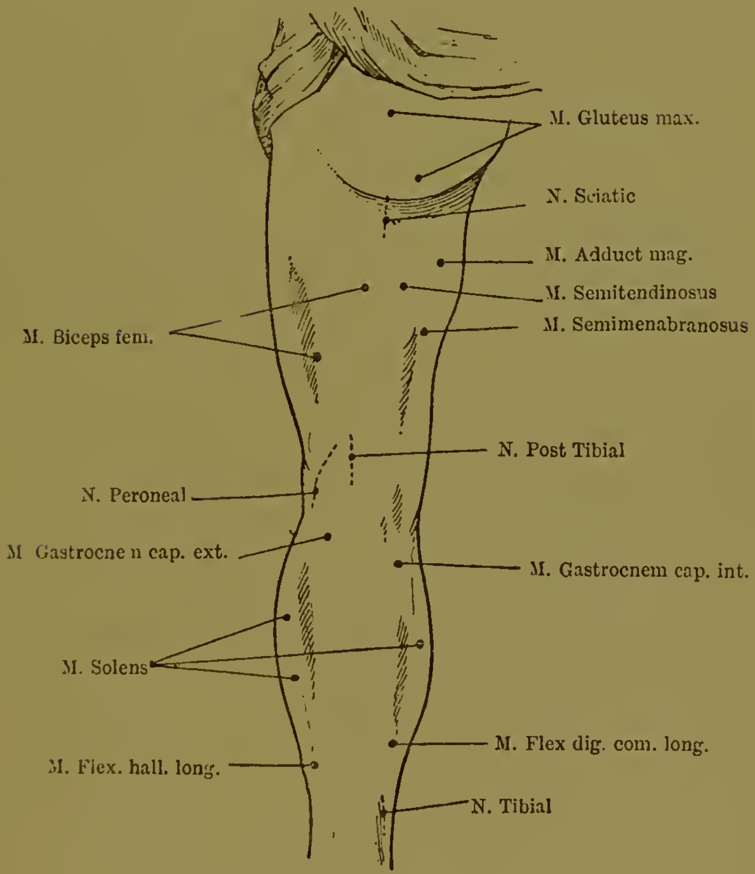


PLATE VI.

MOTOR POINTS.—TRUNK.

M = Muscle. N = Nerve.

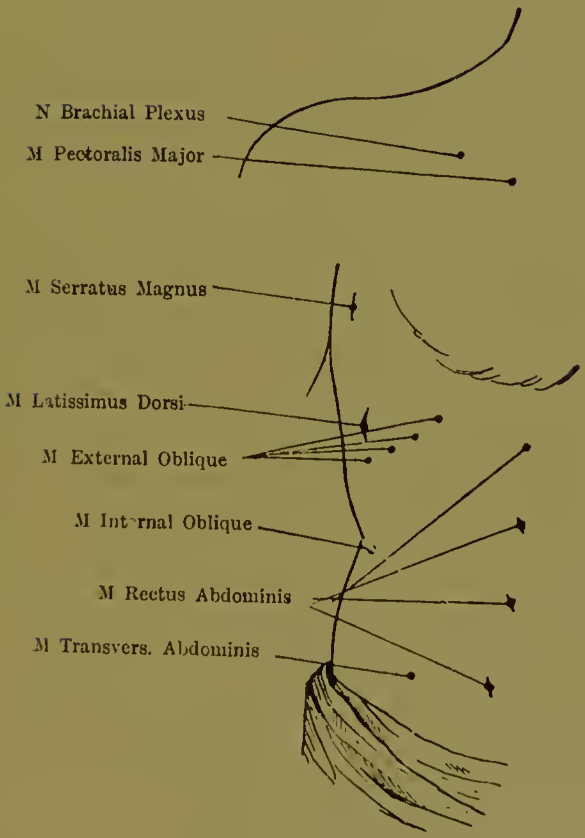
MUSCLE.	ACTION.
Pectoralis major...	Draw arm across chest.
Serratus magnus	Pull scapula forward and downward.
Latissimus dorsi	Pull arm down in striking and turn arm back.
Oblique external	Bend trunk forward.
Do. internal	Do. do.
Rectus Abdominis	Flex chest on pelvis.
Transversalis abdominis	Contract abdomen.

NERVE.	MUSCLE IT SUPPLIES.
Brachial plexus ..	Muscles of upper limbs.

PLATE VI.

MOTOR POINTS. TRUNK.

M = Muscle. N = Nerve.



ELECTRIC BATHS.

In administering Electric Baths special care and tact are required. The temperature of the water should not be less than 90° F. nor more than 100° F., and within these limits may vary according to the fancy of the patient.

The bath should be of porcelain or wood, and well insulated.

Metal baths are very unsatisfactory, and the enamelled metal baths in common use are so slightly insulated that when used for electric baths a large amount of electric leakage is sure to take place sooner or later, and thus the efficiency of the bath be spoiled.

The waste pipe should be insulated by the insertion of a few inches of india rubber pipe in place of the lead at some convenient section near the bath.

To increase the conductivity of the water it is best to put in salt, about 1½ lbs. to 30 gallons will do. It is often advantageous to the patient to use Tidman's sea salt for this purpose though ordinary salt is generally used. As patients often have to remain in the bath 10 or 15 minutes in one position it is necessary to have some arrangement for supporting the body or parts of it in the required position. This may be conveniently done by the means of broad webbing bands or straps attached by means of buckles to the sides of the bath, and capable of adjustment as regards length.

Wooden or other supports resting on the bottom of the bath are sometimes used but are unpleasantly rigid and do not lend themselves so readily to the general support of the body as the flexible suspension bands mentioned above.

Large electrodes should be used. The foot plates may, with advantage, be 12 inches by 6.

It is of little or no use to apply both electrodes under water to the patient's body. The best effect is produced when one pole is applied to some portion of the body which is out of the water, and the other pole is applied to or near some part of the body which is in the water. Simply to electrify the water by placing both electrodes therein, say one near the head and the other near the feet is not, on the whole (though undoubtedly good in some cases) a satisfactory form of electric bath, especially when you have not large battery-power at command.

The reason for this is, that the water is a better conductor than the patient's body, and, consequently, as electric currents always travel by the path of least resistance, by far the greater portion of the current passes **through the water** and **not through the patient**. To illustrate this I may mention that I have often noticed that it has taken as much as 150 milli-ampères with both poles in the water to obtain in the same patient anything like the same sensations which were produced with 15 milli-ampères when one pole only was in the water and the other on some part of the patient's body just out of the water.

The operator should be careful not to alter switches or connections with one hand in the water or upon the patient, as, if this is done, unpleasant shocks may result.

In cases where two electrodes from the same pole are applied to the patient for the first part of the treatment, and then one only is required, special care should be taken to reduce the current strength before the second electrode is moved, or the sudden increase of current through the first electrode will be very unpleasant and perhaps harmful to the patient.

Conversely, in cases where a second electrode of the same polarity is applied after one is *in situ*, the current strength should not be increased till after this second electrode is in position.

In sponging a patient's spine or other part of the body, it is generally more convenient to hold the electrode so that a portion of the sponge comes in contact with the operator's hand rather than by the insulating handle only; when this is the case the other hand should never rest on the patient's body, or touch the water, as then a considerable portion of the current is shunted from the patient and passes through the operator's body.

Never turn the current on till after the patient is in the bath and comfortably in position.

Always turn the current off before the patient gets out of the bath, so that there may be no risk of shocks through touching any of the connections while getting out. It is, however, well to remove all electrodes from direct contact with the patient before turning the current off at the switch board, as the gradual break of circuit so obtained will not produce the sharp shock which might otherwise accompany the switching off of the current.

GENERAL HINTS ABOUT MASSAGE.

1. Let the room in which the operation is to take place be well ventilated, light, cheerful, and comfortable, as regards temperature (from 60° to 65° F.)

2. Let the patient lie on a low couch or bed without sides, so that the operator may get all round it easily, and let the bed or cushions be softly firm. Feather beds or spring beds are very unsuitable.

3. Let the patient be in a comfortable position and so placed that the operator may work in comfort.

4. The operator should divest himself of all rings, cuffs, and ornaments likely to jingle or rattle (such as watch chain and seals) and must on no account wear tight clothing or boots.

5. Always wash the hands *before* touching a patient, as well as after the rubbing is over.

6. Never touch a patient with cold hands.

7. The operator should always take that position which will enable him to do his work with the greatest facility and minimum of inconvenience to himself. By working in a **cramped** or **strained position** he **can do justice neither to his patient nor to himself.**

8. Always keep covered as much of the patient's body as is not immediately under manipulation, covering with a light cloth or rug the parts treated as they are finished with.

9. During the operation talk cheerfully to the patient, but avoid politics, religion, and tittle tattle.

10. Look, speak, and act in as bright and cheerful a manner as possible, but avoid bustle as you would poison.

11. To keep the hands in good condition rub in a little glycerine and water (about equal proportion of each) occasionally at bed time; use soft water to wash with, if possible, and glycerine soap.

PHYSIOLOGICAL DATA.

TABULAR STATEMENT OF THE CIRCULATION OF THE BLOOD, STARTING FROM THE RIGHT AURICLE OF THE HEART.

Right Auricle (Tricuspid Valve).	
Right Ventricle (Semilunar Valve).	
Pulmonary Artery.	
Lungs.	
Pulmonary Veins.	
Left Auricle (Mitral or Bicuspid Valve).	
Left Ventricle (Semilunar Valves).	PORTAL CIRCULATION.
Aorta, by Gastric Artery	Stomach. Small Intestine. Large Intestine.
Do. by Splenic Artery	Spleen. Pancreas. Vena Porta.
Do. by Hepatic Artery ...	Liver.
Arteries of the Body.	
Capillary Arteries.	
Capillary Veins.	Hepatic Vein.
Veins.	
Vena Cavæ (Superior and Inferior).	Vena Cava (Inferior).
Right Auricle.	

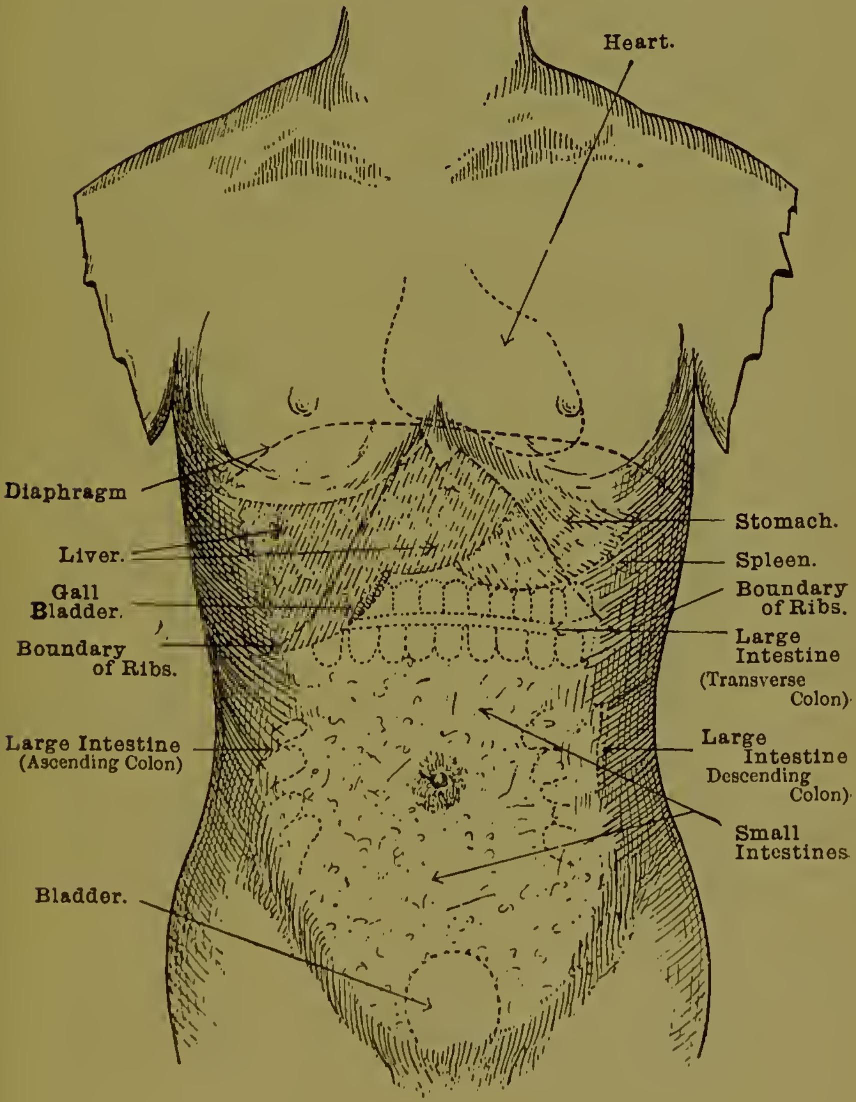
TABULAR STATEMENT REGARDING DIGESTION.

Alimentary Canal.	Process carried on.	Result on Food.
Mouth—		
Teeth	Mastication	Food ground into small particles.
Saliva from parotid, sub-maxillary and sub-lingual glands	Insalivation	Food lubricated, rendered sapid, and by the constituent of the saliva, called Ptyalin, the starch is turned into sugar.
Pharynx	Swallowing.	
Œsophagus or Gullet	Food passed down by muscular action	
(through Cardiac Orifice)		
Stomach	Chymefication	Food turned into Chyme by the Gastric juice, and the Proteid substances turned into Peptone. Gastric juice does not act on starches or fats beyond dissolving the small envelopes or cells in which the fat is contained.
(through Pylorus)		
Small Intestines— *Duodenum* *Jejunum* *Ileum*	Chylification	Chyme acted upon by the Bile, Pancreatic and Intestinal juices, which turn the fatty parts into an emulsion called Chyle. This Chyle is absorbed by the Lacteals. The remaining Peptone is absorbed by the veins. The Pancreatic juice, besides assisting in the above completes any work of digestion which may have escaped the other digestive agents.
Large Intestines— *Ascending Colon* *Transverse Colon* *Descending Colon*	Absorption	The indigestible parts of the food are passed along, and then expelled from the rectum as fæces.

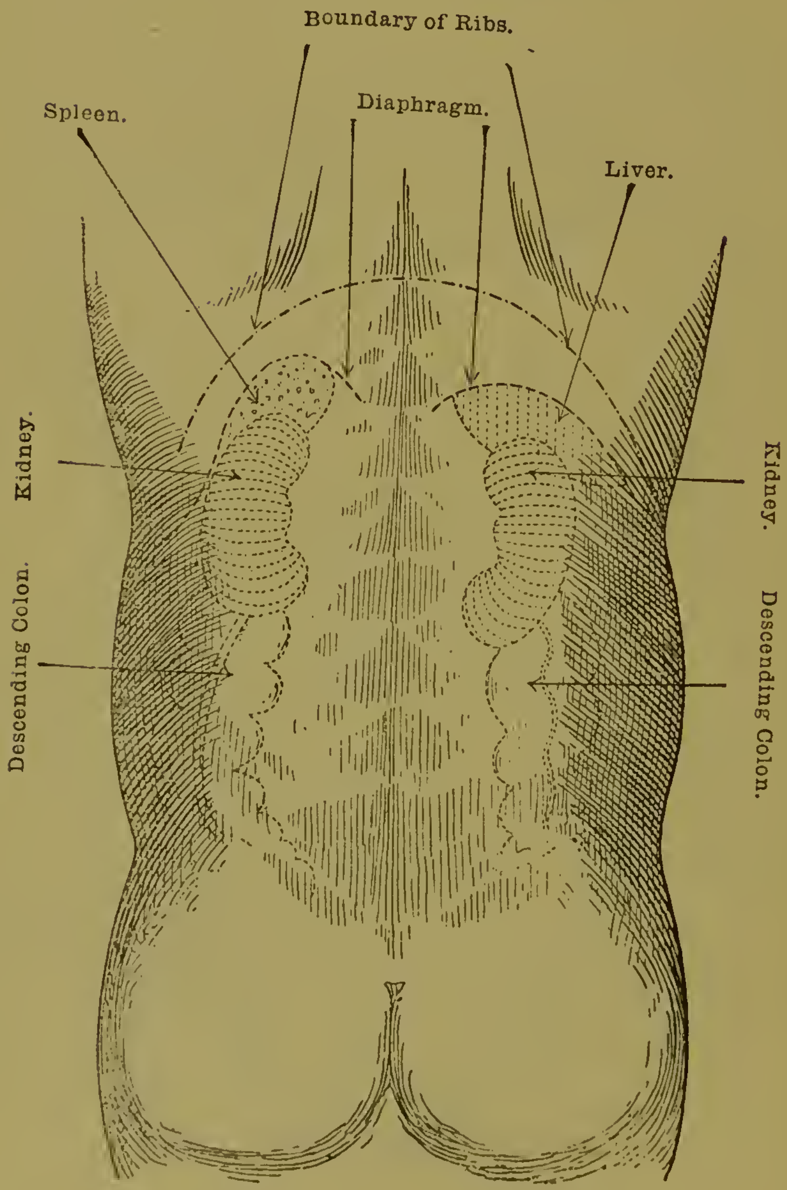
TABULAR STATEMENT OF THE CIRCULATION OF THE LYMPH.

Lacteals, or Lymphatic Vessels of the Intestines.
Receptaculum Chyli.
Thoracic Duct.
Left Subclavian Vein.
Vena Cava (Superior).
Right Auricle.

FRONT VIEW OF TRUNK SHOWING POSITION OF THE MAIN ORGANS IN THE ABDOMEN.



BACK VIEW OF TRUNK SHOWING POSITION OF THE MAIN ORGANS IN THE ABDOMEN.



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